Operation IceBridge - Antarctic Deployment McMurdo 2013

Michael Studinger and Christy Hansen, Code 615, NASA GSFC

Figure 1: NASA's P-3 research aircraft on the sea ice runway in McMurdo, Antarctica. This was the first deployment of a NASA aircraft to Antarctica and the first time a wheeled aircraft has flown science missions deep into the interior of Antarctica from McMurdo.

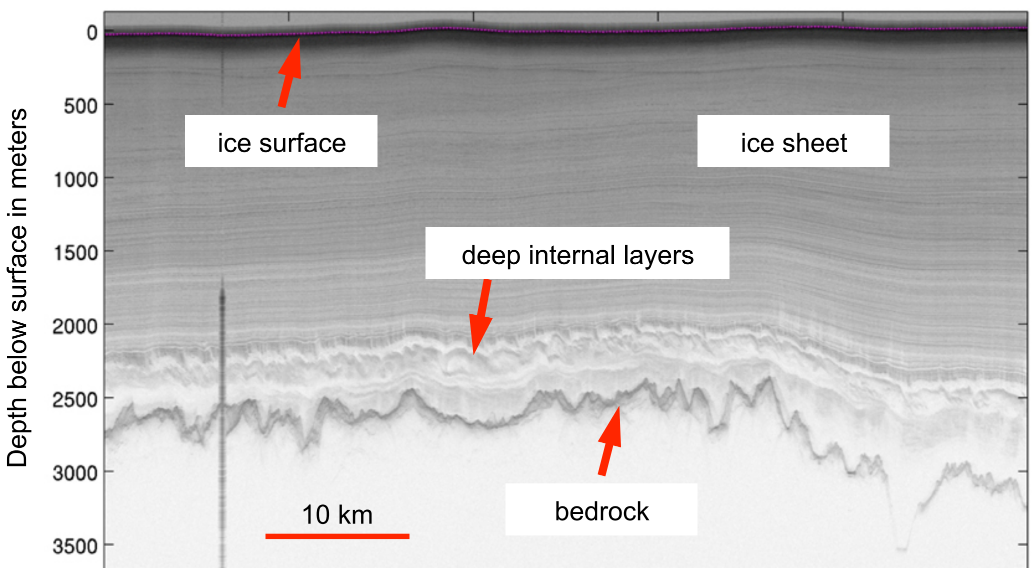

Figure 2: MCoRDS ice penetrating radar data (field processed) from CReSIS/ University of Kansas. Only 4 out of 15 channels have been processed. The data shows never before seen internal layers in the ice sheet close to the bedrock near Dome Concordia in East Antarctica. Internal layers are isochrones that reveal the dynamic history of ice sheets over time.

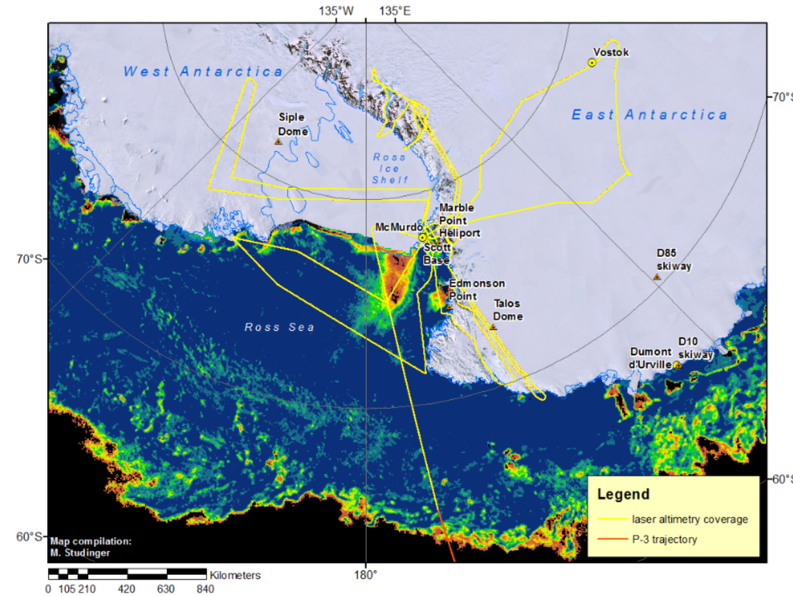

Figure 3: Aircraft trajectories (red) and data coverage (yellow) for the science missions flown from McMurdo. The science targets include areas that have previously been unreachable for IceBridge and establish baselines for ICESat-2 data.

Name: Michael Studinger and Christy Hansen, NASA/GSFC, Code 615
E-mail: michael.studinger@nasa.gov
Phone: 301-614-6908

Abstract:
These slides summarize the accomplishments of the IceBridge deployment to McMurdo Antarctica in Nov/Dec 2013. This was the first time that a NASA aircraft deployed to Antarctica and the first time a wheeled aircraft has flown science missions deep into the interior of Antarctica from McMurdo.

References:
None.

Data Sources: None. All data will be available from the National Snow and Ice Data Center six months after data collection: http://nsidc.org/data/icebridge/index.html

Technical Description of Figures:

Figure 1: NASA's P-3 research aircraft on the sea ice runway in McMurdo, Antarctica. This was the first deployment of a NASA aircraft to Antarctica and the first time a wheeled aircraft has flown science missions deep into the interior of Antarctica from McMurdo.

Figure 2: MCoRDS ice penetrating radar data (field processed) from CReSIS/University of Kansas. Only 4 out of 15 channels have been processed. The data shows never before seen internal layers in the ice sheet close to the bedrock near Dome Concordia in East Antarctica. Internal layers are isochrones that reveal the dynamic history of ice sheets over time.

Figure 3: Aircraft trajectories (red) and data coverage (yellow) for the science missions flown from McMurdo. The science targets include areas that previously have been unreachable for IceBridge and establish baselines for ICESat-2 data.

Scientific significance:
The data collected will allow building a time series of ice surface elevation changes that began with ICESat and will continue with ICESat-2. In addition to changes in ice surface elevation, many critical data sets such as ice thickness have been collected in areas with no data coverage. This was the first time that a large scale, basin-wide, airborne survey was conducted over the sea ice in the Ross Sea.

Relevance for future science and relationship to Decadal Survey:
IceBridge collected data with the P-3 aircraft from McMurdo over many areas that are challenging to reach with smaller aircraft. The data will provide continuity in ice surface observations between ICESat and ICESat-2, in particular over rapidly changing areas such as the Siple Coast Ice Streams. We have established baseline data sets for the upcoming ICESat-2 mission and have begun collecting data over the Dry Valleys in Antarctica in preparation for ICESat-2 calibration and validation.

TEST of SMAP PASSIVE SOIL MOISTURE RETRIEVAL ALGORITHM using SMOS TB and *IN SITU* MEASUREMENTS

Peggy E. O'Neill, NASA GSFC Code 617, Rajat Bindlish, USDA ARS, Steven Chan, JPL

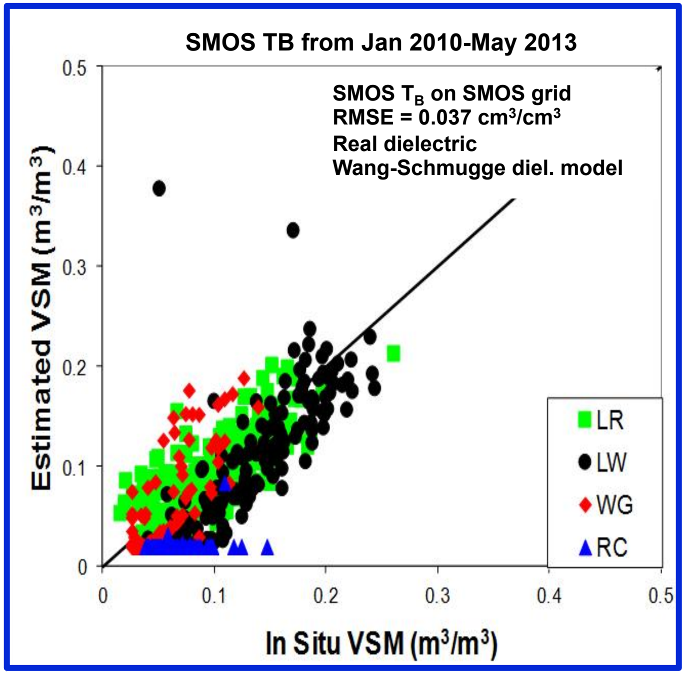

Figure 1. Retrieved soil moisture using SMOS TB in the SMAP L2_SM_P algorithm compared to *in situ* soil moisture from four USDA instrumented watersheds over a 41-month period. Two outliers did not get thrown out during routine flagging: on 2/25/2011, the surface temperatures were very low and there is likely some wet snow in the SMOS footprint that was not predicted; on 9/16/2011, there is an active rain event that was not predicted.

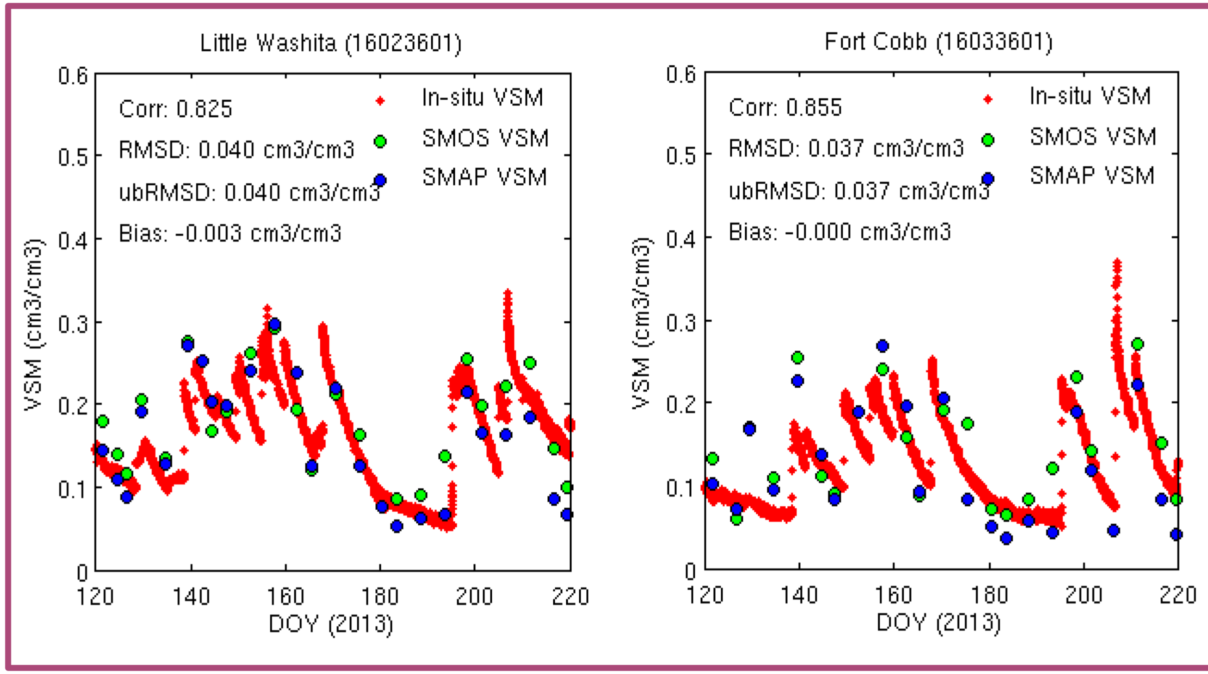

Figure 2. Comparison of retrieved and measured soil moisture in time series for two instrumented USDA watersheds in Oklahoma during the SMAP cal/val rehearsal campaign #1 in Summer, 2013. *In situ* soil moisture measurements from the instrumented watersheds are in red; retrieved soil moisture using SMOS TB in the SMAP algorithm are in blue. SMOS soil moisture using the SMOS algorithm are in green for comparison.

Name: Peggy E. O'Neill, NASA/GSFC, Code 617
E-mail: Peggy.E.ONeill@nasa.gov
Phone: 301-614-5773

Abstract: In order to test the SMAP passive-only soil moisture retrieval algorithm (L2_SM_P) in the prelaunch timeframe, SMOS TB were used as a surrogate input for SMAP TB, and the resulting retrieved soil moistures were compared against *in situ* measurements of soil moisture in several instrumented USDA watersheds across the U.S. Results indicate that the SMAP L2 passive algorithm is likely to meet its target accuracy requirement of 0.04 cm^3/cm^3 in retrieved soil moisture.

References:

Entekhabi, D., E, Njoku, P. O'Neill, K. Kellogg, plus 19 others, "The Soil Moisture Active Passive (SMAP) Mission," *Proceedings of the IEEE*, Vol. 98, No. 5, May, 2010.

O'Neill, P., S. Chan, E. Njoku, T. Jackson, and R. Bindlish, *Algorithm Theoretical Basis Document for SMAP L2 and L3 Radiometer Soil Moisture (Passive) Data Products: L2_SM_P and L3_SM_P*, Initial Release v.1, JPL, Pasadena, CA, October, 2012.

Jackson, T. J., Bindlish, R., Cosh, M. H., Zhao, T., Starks, P. J., Bosch, D. D., Moran, M. S., Seyfried, M. S., Kerr, Y., and Leroux, D., "Validation of soil moisture and ocean salinity (SMOS) soil moisture over watershed networks in the U.S," *IEEE Transactions on Geoscience and Remote Sensing*, 50: 1530-1543, 2012.

Data Sources: Brightness temperature (TB) data form ESA's SMOS mission have been used as surrogates for SMAP brightness temperatures for use in testing SMAP algorithms prior to the SMAP launch in November, 2014. SMOS data have the same frequency (L band at 1.4 GHz), approximately the same spatial resolution (~ 40 km), and are taken at the same local time (6 am/6 pm orbit) as the SMAP radiometer. SMOS data have been processed to pull out only the 40 deg incidence angle data to match the SMAP angle.

Technical Description of Image: The SMAP retrieval algorithm for the passive-only soil moisture product (L2_SM_P; see O'Neill et al., 2012) was tested using SMOS brightness temperatures at a 40° incidence angle as a surrogate for SMAP TB. The retrieved soil moistures were then compared to measured soil moisture from *in situ* instrument networks in USDA watersheds across the U.S. (see Jackson et al., 2012 for a description of the watersheds). Comparisons were done over a 41-month period (January 2010 – May 2013) and presented as a scatter plot in Figure 1. More recently, time series comparisons were done using the anticipated SMAP grids and ancillary data during the SMAP Cal/Val Rehearsal-1 campaign in June-August, 2013; results from two USDA watersheds in Oklahoma from the cal/val rehearsal are shown in Figure 2.

Scientific significance: Results of SMAP prelaunch studies testing candidate retrieval algorithms for SMAP soil moisture products indicate that the SMAP passive-only baseline algorithm is likely to meet its mission requirement to retrieve soil moisture to within an accuracy of 0.04 cm^3/cm^3.

Relevance for future science and relationship to Decadal Survey: Soil moisture is a critical control on water and energy cycles, as well as providing information important for improved weather, climate, hydrological and agricultural predictions. Prelaunch testing of algorithms is required to demonstrate that SMAP will be able to meet its requirements for accuracy in retrieved soil moisture once launched. The availability of SMOS TB data as a surrogate for SMAP TB data enabled algorithm testing using actual measured data from orbit, greatly enhancing the fidelity of the algorithm studies.

Long-term Trends and Interannual Variability of Forest, Savanna, and Agricultural Fires in South America

Douglas Morton & Jim Collatz, Code 618, NASA GSFC

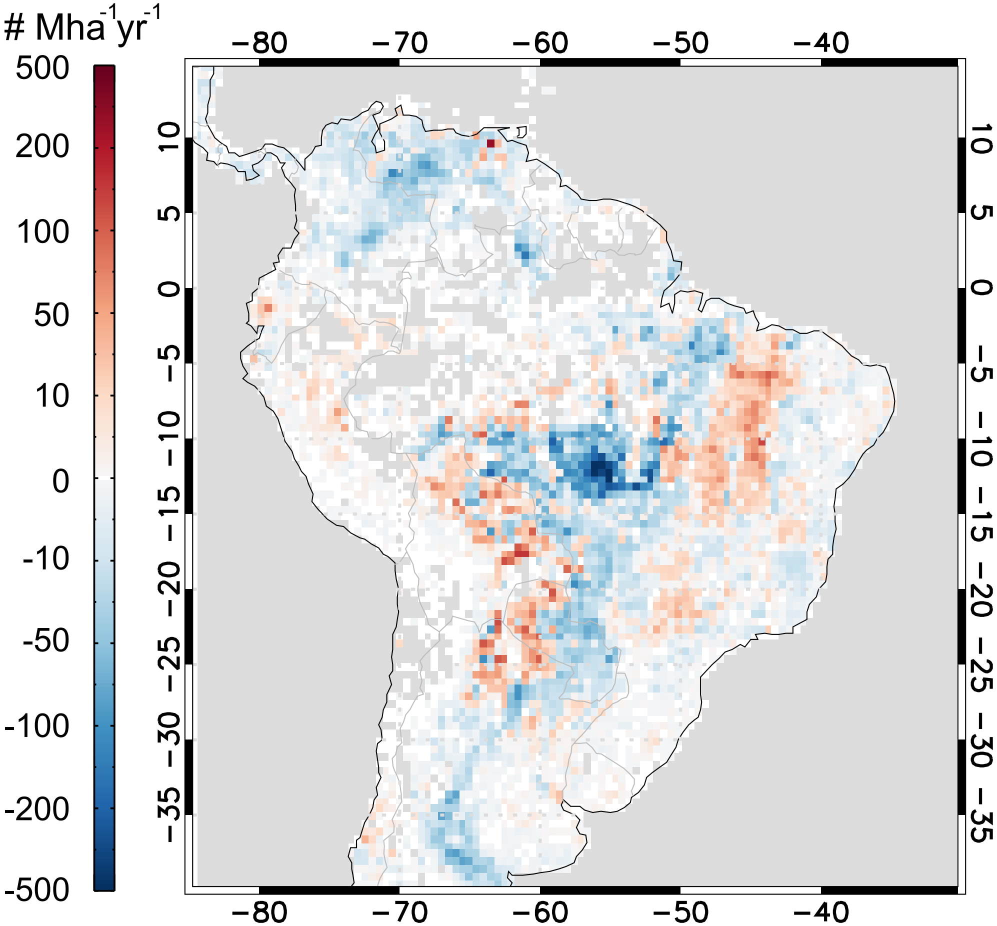

Figure 1. Trends in MODIS Terra active fire detections 2001-2012.

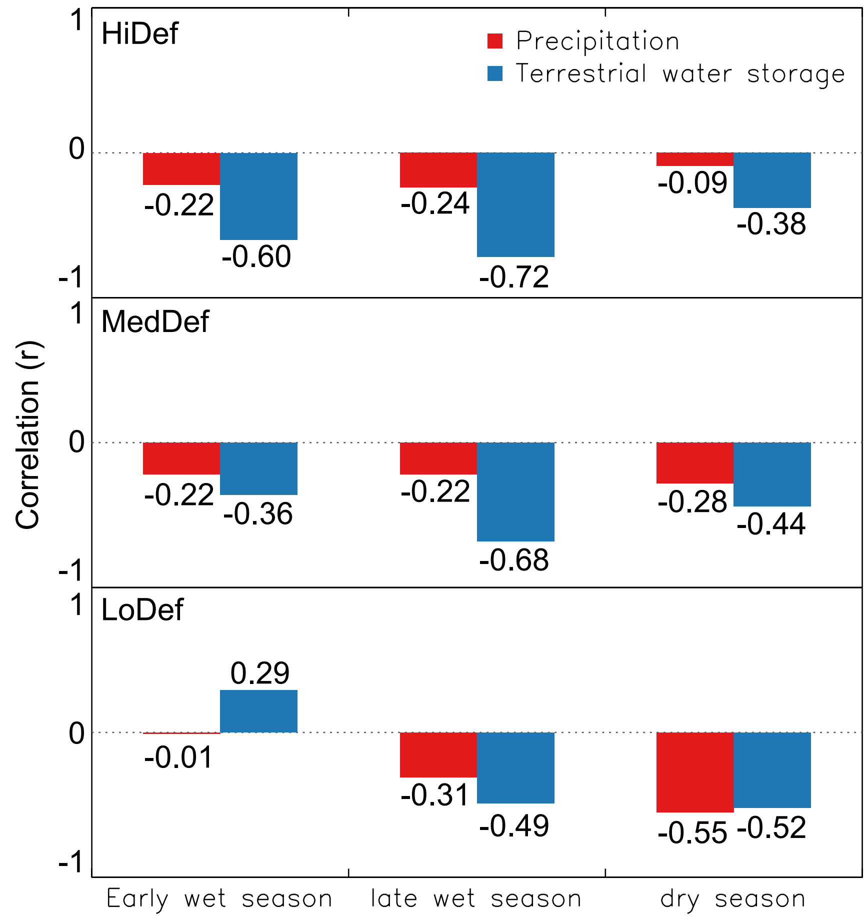

Figure 2. GRACE terrestrial water storage anomalies in the late wet season were strongly correlated with interannual variability in fire activity along the Amazon frontier.

Name: Douglas Morton, NASA-GSFC
E-mail: douglas.morton@nasa.gov
Phone: 301-614-6688

Abstract: Background: Landscape fires in South America have considerable impacts on ecosystems, air quality and the climate system. We examined long-term trends and interannual variability of forest, savanna and agricultural fires for the continent during 2001–2012 using multiple satellite-derived fire products. **Results:** The annual number of active fires in tropical forests increased significantly during 2001–2005. Several satellite-derived metrics, including fire persistence, indicated that this trend was mostly driven by deforestation. Fires between 2005 and 2012 had a small decreasing trend and large year-to-year changes that were associated with climate extremes. Fires in savannas and evergreen forests increased in parallel during drought events in 2005, 2007 and 2010, suggesting similar regional climate controls on fire behavior. Deforestation fire intensity (the number of fires per unit of deforested area) increased significantly within the Brazilian Amazon in areas with small-scale deforestation. **Conclusion:** Fires associated with forest degradation are becoming an increasingly important component of the fire regime and associated carbon emissions.

Reference:
Yang Chen, D.C. Morton, Y. Jin, G.J. Collatz, P.S. Kasibhatla, G. van der Werf, R.S. DeFries, J.T. Randerson. 2013. Long-term trends and interannual variability in of forest, savanna, and agricultural fires in South America. Carbon Management 4(6), 617-638.

Data Sources: This study analyzed fire-climate relationships using active fire detections, fire emissions data, land cover information, and satellite-based estimates of precipitation and terrestrial water storage anomalies. Specifically, we analyzed time series of active fire detections from MODIS (MOD14/MYD14), ATSR, and TRMM to characterize long-term trends in fire activity by biome, country, and level of recent deforestation activity. Global Fire Emissions Database (GFED) estimates of burned area and fire carbon emissions were used as independent measures of fire activity (www.globalfiredata.org). Estimates of deforestation in the Brazilian Amazon were derived from annual deforestation monitoring with Landsat data (INPE PRODES). Deforestation estimates for other areas were derived from 18.5 km estimates of forest loss by Hansen et al., (2008). Finally, TRMM estimates of monthly precipitation (3B43v6) and GRACE monthly terrestrial water storage anomalies (Tellus R04) were used to assess climate-fire relationships in South America.

Technical Description of Image:
Figure 1: Trend in active fire detections from the Terra MODIS sensor from 2000-2012, summarized at 0.05 degree resolution for South America. Red areas had increasing fire detections, while blue areas had declining linear trends in MODIS active fire detections over the study period. Strong negative trends in the Brazilian state of Mato Grosso highlight the dramatic decline in deforestation between 2005-2012 along the “arc of deforestation” at the southern and eastern extents of Amazon forests. Dry forests in the Gran Chaco region and Cerrado woodland areas of Brazil experienced the strongest increasing trends in fire activity.

Figure 2: Correlation between fire season severity, a measure of total satellite active fire detections, and climate conditions for regions with low, medium, and high rates of deforestation during 2000-2005. Fire activity was more strongly correlated with GRACE terrestrial water storage anomalies than TRMM precipitation, and conditions in the late wet season were more important than dry season conditions for total fire activity in deforestation regions.

Scientific significance: Long-term trends in fire activity offer several key scientific insights regarding fire activity and fire-climate interactions in South America: 1) MODIS-based active fire, burned area, and fire emissions estimates highlight increasing (2001-2005) and decreasing (2006-2012) deforestation in Amazonia. Increases in fire activity in Chaco dry forests partially offset declines in Amazonia. 2) Although projections of climate–fire relationships in Amazonia typically emphasize dry season precipitation, our results suggest that wet season precipitation may be a more important control on regional fire activity and associated carbon emissions. 3) Fires in savanna and tropical forest biomes both increased in response to drought events in 2005, 2007 and 2010, highlighting the role of regional climate conditions for fire season severity in different biomes. 4) Fires associated with forest degradation are becoming an increasingly important component of the fire regime and associated carbon emissions.

Relevance for future science and relationship to Decadal Survey: Long time series of satellite observations offer a unique perspective on changes in natural and managed ecosystems. With more than a decade of observations from the MODIS sensors, long-term trends and interannual variability in fire activity shed light on the underlying processes of fire risk in natural ecosystems and human-dominated fire regimes. The continuity of space-based fire observations is therefore critical to assess changing dynamics of land use fire activity and changing fire regimes in response to climate warming. Evidence for a strong link between fire activity and terrestrial water storage in the late wet season opens new avenues for satellite-based monitoring of fire risk. In particular, our findings suggest that near-real time GRACE data products may be an important addition to existing fire forecasting systems.